

## Ascid mites (Acari: Mesostigmata: Ascidae) from Costa Rican hummingbirds (Aves: Trochilidae), with description of three new species and a key to the *Proctolaelaps belemensis* species group

FRANTISEK DUSBABEK<sup>1</sup>, IVAN LITERAK<sup>2</sup>, MIROSLAV CAPEK<sup>3</sup> & MARTIN HAVLICEK<sup>4</sup>

<sup>1</sup>Biology Centre of the AS CR, Institute of Parasitology, Academy of Sciences of the Czech Republic, Branisovska 31, 370 05 Ceske Budejovice, Czech Republic. E-mail: dusf@paru.cas.cz

<sup>2</sup>Department of Biology and Wildlife Disease, Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences, Palackeho 1-3, 612 42 Brno, Czech Republic. E-mail: literaki@vfu.cz

<sup>3</sup>Department of Avian Ecology, Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Kvetna 8, 603 65 Brno, Czech Republic. E-mail: capek@brno.cas.cz

<sup>4</sup>Veterinary Teaching Hospital, School of Veterinary Science and Animal Production, University of Queensland, St Lucia, Queensland 4072, Australia. E-mail: martinh@bvsc.com.au

### Abstract

Eleven species of hummingbird flower mites of the genera *Proctolaelaps* Berlese, 1923, *Tropicoseius* Baker & Yunker, 1964 and *Rhinoseius* Baker & Yunker, 1964 were recorded from hummingbirds in Costa Rica. Three new species of the genus *Proctolaelaps* are described and figured, i.e. *P. threnetes* Dusbabek & Literak, **sp. nov.**, *P. naskreckii* Dusbabek & Havlicek, **sp. nov.** and *P. chalybura* Dusbabek & Capek, **sp. nov.** A key for identification of females and males of the *P. belemensis* species group is included. Five species of the genus *Tropicoseius* and three species of the genus *Rhinoseius* are recorded, three of these species are recorded from Costa Rica for the first time.

**Key words:** Hummingbird flower mites, Ascidae, *Proctolaelaps*, *Rhinoseius*, *Tropicoseius*, Trochilidae, Costa Rica.

### Introduction

The family Ascidae comprises more than 22 genera, with several hundred predatory and microphytophagous species distributed around the world (Lindquist & Evans, 1965; Evans, 1992). The genera *Lasioseius* Berlese, 1916, *Proctolaelaps* Berlese, 1923, *Rhinoseius* Baker & Yunker, 1964 and *Tropicoseius* Baker & Yunker, 1964 share a tendency to phoresy, some of them with an obligate affiliation with the flowers of hummingbird-pollinated plants. They feed on nectar and pollen, and are transported as phoronts between inflorescences in the nasal cavities of hummingbirds (Naskrecki & Colwell, 1998). These mites are commonly known as hummingbird flower mites (Colwell, 1973). However, some related species are distributed also by Central and South American bats (Tschapka & Cunningham, 2004) or by African honey guides (Indicatoridae) and sunbirds (Nectariniidae) (Ryke, 1964; Fain & Mariaux, 1991). Several species of *Proctolaelaps* are commonly transported by Coleoptera, Lepidoptera and Hymenoptera (Treat & Niederman, 1985; Karg, 1985).

Altogether, 15 species of hummingbird flower mites have been reported from Costa Rica: *Lasioseius aquilarum* Dusbabek & Literak, 2006, *Proctolaelaps kirmsei* Fain *et al.*, 1977, *Rhinoseius richardsoni* Hunter, 1972, *R. tiptoni* Baker & Yunker, 1964, *Tropicoseius chiriquensis*, Baker & Yunker, 1964, *T. erro* Baker & Yunker, 1964, *T. heliconiae* Baker & Yunker, 1964, *T. venezuelensis* Baker & Yunker, 1964, *T. colwelli* (Hunter, 1972), *T. colombiensis* (Fain & Hyland, 1980), *T. analis* (Fain & Hyland, 1980), *T. klepticos* (O'Connor *et al.*, 1996), *T. chazdonae* Naskrecki & Colwell, 1998, and *T. ochoai* Naskrecki & Colwell, 1998 (Baker

& Yunker, 1964; Hunter, 1972; Fain *et al.*, 1977a, 1977b; Fain & Hyland, 1980; Fain, 1992; OConnor *et al.*, 1996; Naskrecki & Colwell, 1998; Dusbabek & Literak 2006).

Ascid mites from hummingbird nares were collected in Costa Rica by the junior authors during their ornithological investigations in 2004. Mites of the genera *Pellonyssus* Clark & Yunker, 1956 (Macronyssidae) and *Lasioseius* Berlese, 1916 (Ascidae) collected during this study have been described in previous papers (Dusbabek *et al.*, 2006; Dusbabek & Literak, 2006). Here we focus on ascid mites of the genera *Proctolaelaps* Berlese, 1923, *Rhinoseius* Baker & Yunker, 1964 and *Tropicoseius* Baker & Yunker, 1964.

## Study Areas

All the field work was performed in two places about 60 km apart in southeastern Costa Rica, in the Cordillera de Talamanca mountain range in Limon province. The birds were studied at these places on the Caribbean slope that differed in elevation and habitat characteristics.

In the first location, the study was carried out in a lowland rainforest within Hitoy Cerere BR (Biological Reserve) (9°40'N, 85°05'W). This site is characterized by a secondary forest at an elevation of about 100 m and a primary forest at an elevation of about 120 m. The primary forest represents Lowland Atlantic Wet Forest. It is a tall, multistratal, evergreen forest characterized by enormous trees over 40 m tall with high buttresses. The canopy layer is dominated by *Anacardium excelsum*, *Hura crepitans*, *Licania* sp., *Brosimum* sp., *Pouteria clistphylla*, *Ticodendron incognitum*, *Beilschmiedia* sp., *Nectandra* sp., *Ocotea* spp., and *Terminalia amazona*. The understory is not very dense, and rich in palms and species that are less frequent in the secondary forest, such as *Zamia skinerii*. The forest has abundant *Asterogyne martiana*, and representatives of the genera *Chamaedorea*, *Dieffenbachia*, *Faramea*, *Psychotria*, *Parmentiera*, *Piper*, and *Drymonia*. The shrub layer consists of dwarf palms and giant broad-leaved herbs. The ground layer is sparse with occasional ferns. Woody lianas are not common and epiphytic shrubs and strangling trees are rare (Donato & Kandler, 1994; Savage, 2002). The secondary forest is characterized by similar plant communities as the primary forest. However, there are minor differences such as higher abundance of *Hura crepitans* and *Apeiba membranacea* trees. The original vegetation was replaced in successional stages and there are no endemic or rare plant species (Donato & Kandler 1994). Although rainfall occurs throughout the year (mean annual rainfall 3,500 mm), it is not evenly distributed. The dry season extends from January through April and the wet season from May through December. Seasonal fluctuations in temperature and relative humidity are low with a 25 °C mean temperature (Haase & Pröhl, 2002).

The second study area was a narrow strip of a water-logged pasture located near the Barbilla NP (National Park) (9°59'N, 85°27'W) at an elevation of about 570 m. Most native vegetation here has been changed by intensive grazing, burning and cultivation. Scattered individual trees have been left standing. The pasture is flanked by secondary growth and remnants of the destroyed forest. The mean annual rainfall is between 3,500 and 4,500 mm (Universidad de Costa Rica, 2004) The mean annual temperature at the elevation of the study site is about 24 °C (Savage, 2002). The adjacent national park is almost entirely covered in lowland tropical rainforest, comprising species such as *Virola sebifera* and *Astrocaryum alatum* (Universidad de Costa Rica, 2004).

In addition, four hummingbird feeders were examined at Turrialba Lodge, at 2,800 m elevation. The feeders were frequently visited by hummingbirds *Selasphorus flammula* (Salvin, 1865), *Panterpe insignis* (Cabani & Heine, 1860) and *Eugenes fulgens* (Swainson, 1827).

## Material and Methods

Birds were studied in the rainy season between August 17 and September 11, 2004 at Hitoy Cerere BR and Barbilla NP. At these sites, dawn-to-dusk mist-netting was conducted to capture as many bird species and individuals as possible to collect ectoparasites. A line of about 100 m of mist nets were checked at least once an hour. Every individual bird was identified, sexed and aged using the books by Ridgely & Gwynne (1989), Stiles & Skutch (1989), Kaufman (1990), Sibley (2000), and the National Geographic Society (2002) handbook. Captured birds were processed and released back into the wild as quickly as possible to minimize disturbance. A total of 530 individuals of 79 bird species was examined, among them 137 hummingbirds belonging to 9 species. Hummingbird flower mites were stored in 70% ethanol and mounted in Hoyer's medium. An Amplival Zeiss (Jena) microscope was used for morphological studies. Figures were drawn using a drawing tube. All measurements are given in micrometres ( $\mu\text{m}$ ).

## Results

### Genus *Proctolaelaps* Berlese, 1923

#### *Proctolaelaps threnetes* Dusbabek & Literak, sp. nov.

(Figs. 1–9)

*Type material*: Female holotype, male paratype and five female paratypes ex *Threnetes ruckeri* (Bourcier, 1847), Costa Rica, Barbilla NP, 570 m elevation, September 2004, coll. I. Literak. Female holotype, male paratype on one slide deposited at the type collection of the Biology Centre of the AS CR, Institute of Parasitology, Ceske Budejovice, Czech Republic, under the accession number CSAV 2005. Paratypes are deposited in the collection of the British Museum (Natural History), London, UK, in the Museum of Biological Diversity, the Ohio State University, 1315 Kinnear Road, Columbus, OH 43212, USA, and in the Instituto Nacional de Biodiversidad, P.O.Box 22-3100, Santo Domingo de Heredia, Costa Rica.

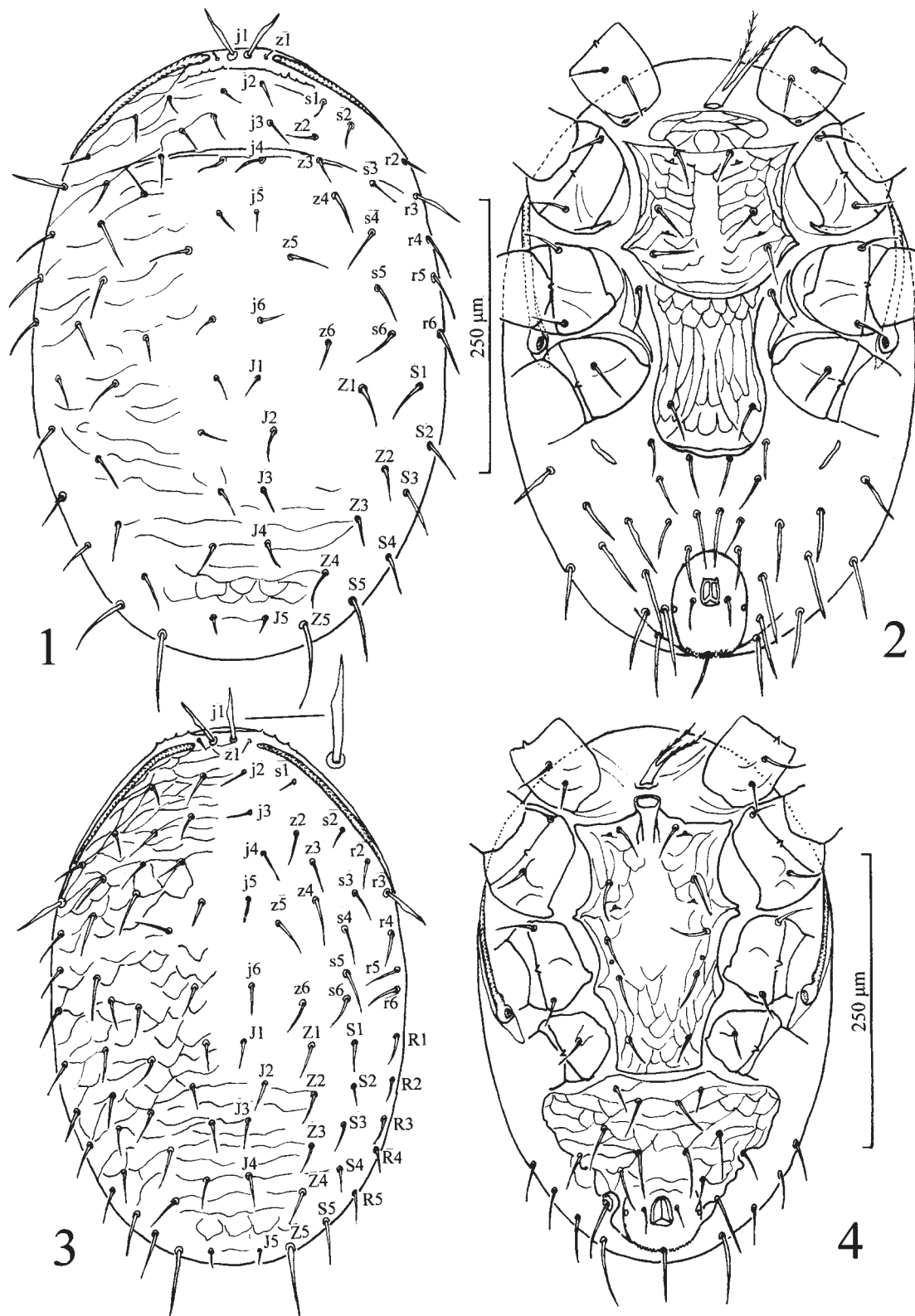
*Material examined*. Two males and 25 females ex 6 specimens of the same host, locality and data as the holotype; 2 males and 26 females ex 7 specimens of *Eutoxeres aquila* (Bourcier, 1847), 3 females ex *Phaethornis superciliosus* (L., 1766) and 2 females ex one specimen of *Chalybura urochrysis* (Gould, 1861) of the same data and locality; 2 females ex *Threnetes ruckeri*, Hitoy Cerere BR, August 2004; 3 females ex 3 specimens of *Phaethornis superciliosus* and 3 females ex 2 specimens of *Phaethornis longuemareus* (Lesson, 1832) of the same data and locality; all coll. I. Literak.

**Diagnosis.** Species of the *P. belemensis* group with setae *j1* and *r3* with lateral bulbous swelling. Relatively large species, with female body length frequently exceeding 600  $\mu\text{m}$ . Dorsal plate with 43 pairs of setae, setae *r2–r6* on the plate. Setae *j5* short (15–22) setae *z5* long (32–39), setae *S5* long (42–54). Spermatodactyl of male very long (250–332), strong ventral spine on femur IV absent.

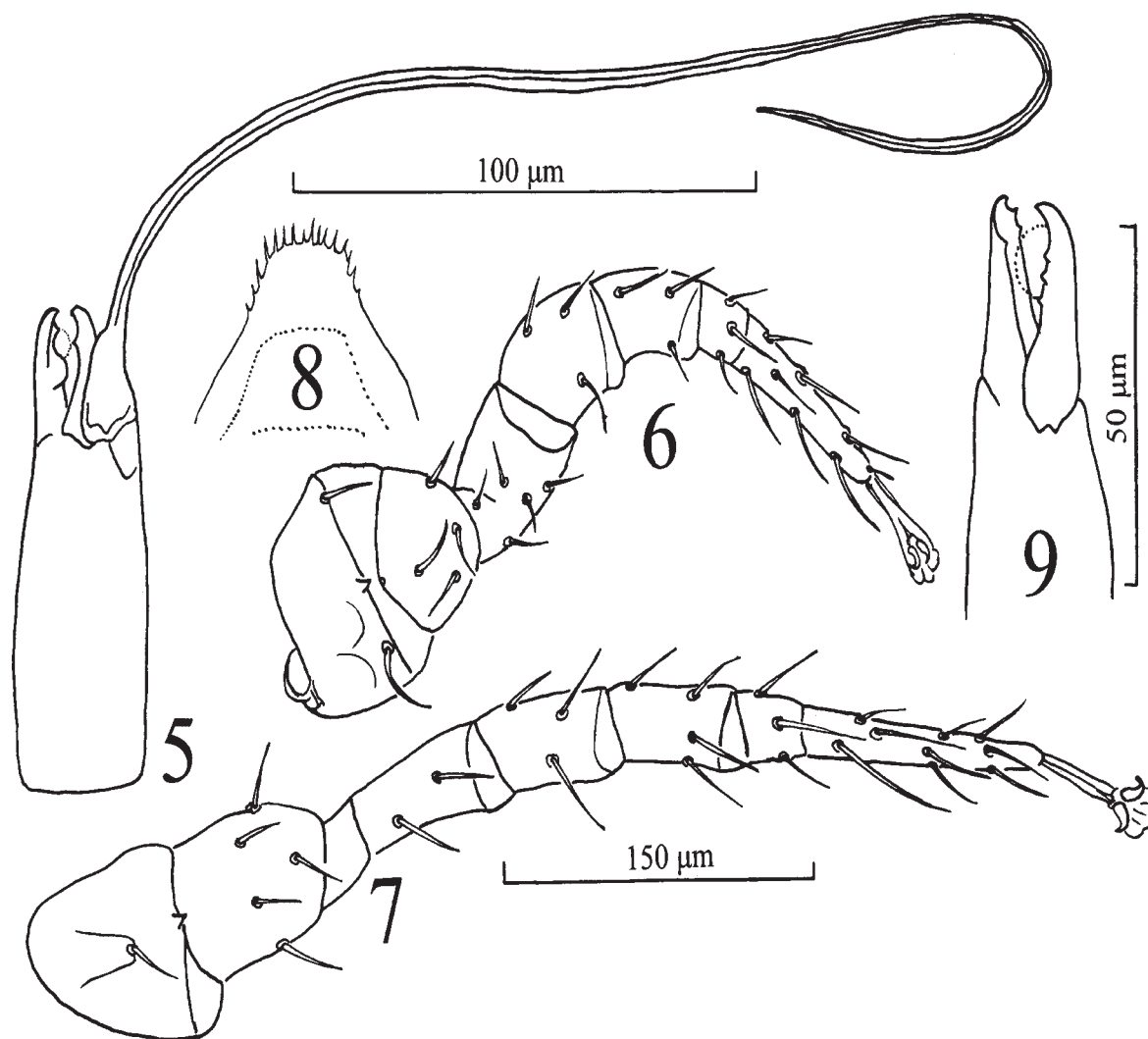
**Female** (Holotype). *Dorsum*: Unfed specimen with body length 564 (614–620 in five paratypes), width 385 (401–420). Dorsal plate 552 (539–570) long, 376 (351–401) wide, finely structured, with row of small denticles on its anterior margin. There are 43 pairs of setae on the plate, series *j*, *z* and *s* each with 6 pairs of seta, series *r* with 5 pairs. Series *J*, *Z* and *S* each with 5 pairs of setae. Setae *j1* and *r3* with lateral bulbous swelling, setae *Z5* setiform. Setae *j1* measuring 44 (40–44), *j5* 17 (15–22), *z5* 32 (32–39), *r2* 32 (30–36), *r3* 42 (40–47), *J5* 12 (12–15), *S5* 51 (42–51), *Z5* 93 (88–95). Peritreme reaching setae *z1*, peritremal plate narrow.

*Venter*: Sternal plate 137 (135–164) long (presternum included), 137 (133–147) wide, finely structured, with 3 pairs of sternal setae and 2 pairs of lyriform pores. Setae *St1* length 38 (37–42), *St2* and *St3* 44 (41–44), *Mst* 44 (42–49). Distance *St1–St2* 56 (54–61), *St2–St3* 37 (34–39). Genital plate broad and rounded at the end, slightly enlarged posterior to coxa IV, finely structured. Genital setae 39 (37–44) long. Anal plate egg-shaped,

anal setae situated at posterior margin of anal pore, 113 (103–115) long, 78 (74–87) wide. Adanal setae 22 (22–27), post-anal seta 74 (69–95) long. Unsclerotised integument with 15 pairs of setae, some of them with lateral bulbous swelling. Setae *Jv1* 37 (39–44) long, *Jv2* 49 (41–54), *Jv5* 87 (74–88). Endopodal platelets present, metapodal platelets small and narrow (32x8), situated posterior to coxa IV.



**FIGURES 1–4.** *Proctolaelaps threnetes* Dusbabek & Literak, **sp. nov.** Fig. 1. Female dorsum. Fig. 2. Female venter. Fig. 3. Male dorsum. Fig. 4. Male venter.



**FIGURES 5–9.** *Proctolaelaps threnetes* Dusbabek & Literak, **sp. nov.** Fig. 5. Chelicera and spermatodactyl of male. Fig. 6. Leg II of male, ventrally. Fig. 7. Leg IV of male, ventrally. Fig. 8. Epistome of female. Fig. 9. Chelicera of female.

*Gnathosoma*: Deutosternum with 7 rows of denticles, 5<sup>th</sup> and 6<sup>th</sup> rows widened and curved. Corniculi pointed and curved inward. Epistome rounded and strongly toothed. Fixed chela with three fine subapical teeth, movable chela with three lateral teeth and membranous lobe. Inner seta on palpfemur and palpgenu flattened at the tip.

*Legs*: Tibia III with 8–9 setae, tibia IV with 10 setae.

**Male. Dorsum**: Body oval, 483 long (478–489 in five paratypes), 326 (282–314) wide. Dorsal plate 458 (464–480) long, 307 (280–310) wide, with fine scale-like structure as shown on figures, covered with 43 pairs of setae. All setal series complete, except *r* series lacking setae *r1*. Setae *r2*–*r6* and *R1*–*R5* situated on the plate. Setae *j1* and *r3* strong, with lateral bulbous swelling. Setae *j1* spine-like, 37 (32–37) long, setae *j5* short, measuring 27 (17–23) only, setae *z5* longer, measuring 32 (30–34). Setae *J5* minute, 12 (11–12) long, setae *Z5* stout, spine-like, 78 (74–83) long. Setae *r2* fine, 27 (24–27) long, setae *r3* 40 (34–39) long. Anterior margin of dorsal plate finely denticulate. Peritreme reaching setae *z1*. Peritremal shield narrow.

**Venter**: Genitoventral plate triangular, 233 (228–236) long (including genital pore), 130 (120–127) wide, finely structured, with 5 pairs of setae 38–42 (30–44) long. Two pairs of lyriiform pores close to *Gv1* and *Gv2*, and a pair of small circular pores between *Gv3* and *Gv4*. Ventri-anal plate broadly triangular, finely structured, with 6 pairs of setae anterior to anal pore, a pair of adanal setae and unpaired post-anal seta. The length of



these setae is as follows: *Jv1* 39 (32–38), *Jv2* 49 (42–47), *Jv5* 65 (60–74), *Zv1* 30 (25–32).

**Gnathosoma:** Deutosternum with 7 rows of denticles, 5<sup>th</sup> and 6<sup>th</sup> rows widened and bent. Spermatodactyl extremely long, measuring 275 (250–332).

**Legs:** Legs II slightly thickened. Strong ventral spine on femur IV absent. All setae on legs setiform and smooth. Tibia III with 9 setae, tibia IV with 10 setae.

**Notes.** This new species belongs to the *P. belemensis* species group. The new species differs from other species of this group, i.e. *P. belemensis* Fain *et al.*, 1977, *P. contumex* OConnor *et al.*, 1991, *P. certator* OConnor *et al.*, 1991 and *P. contentiosus* OConnor *et al.*, 1991 mainly in the short *j5* and long *z5* setae, strong *r3* and *S5* setae and the lateral bulbous swelling on *j1*, *r3* and some ventral setae. The male of the new species is characterized by an extremely long spermatodactyl and the absence of ventral spine on femur IV.

**Etymology.** The name of the new species is derived from the generic name of its type host, *Threnetes ruckeri*.

### ***Proctolaelaps naskreckii* Dusbabek & Havlicek, sp. nov.**

(Figs. 10–16)

**Type material.** Female holotype and male paratype ex *Threnetes ruckeri*, Costa Rica, Barbilla NP, 570 m elevation, September 2004, coll. I. Literak. Female holotype, and male paratype (one slide) are deposited at the type collection of the Biology Centre of the AS CR, Institute of Parasitology, Ceske Budejovice, Czech Republic, under accession number CSAV 2006. Some paratypes are deposited in the collection of the British Museum (Natural History), London, UK, in the Museum of Biological Diversity, the Ohio State University, 1315 Kinnear Road, Columbus, OH 43212, USA, and in the Instituto Nacional de Biodiversidad, P.O.Box 22-3100, Santo Domingo de Heredia, Costa Rica.

**Material examined.** Three females ex *Threnetes ruckeri*; 3 females ex 3 specimens of *Eutoxeres aquila*; 1 male and 11 females ex 6 specimens of *Phaethornis superciliosus*; 3 females ex one specimen of *Chalybura urochrysia*; 1 male and 3 females ex *Amazilia tzacatl* (De la Llave, 1833), all of the same data and locality as holotype; 2 females ex *Threnetes ruckeri*, Hitoy Cerere BR, August 2004; 1 male and 31 females ex 13 specimens of *Phaethornis superciliosus*; 5 females ex 3 specimens of *Phaethornis longuemareus*; 1 male and 11 females ex *Glaucis aenea* Lawrence, 1867; 1 male and 8 females ex 2 specimens of *Amazilia tzacatl*; 1 male and 11 females ex 2 specimens of *Chalybura urochrysia*, all of the same data and locality; all coll. I. Literak.

**Diagnosis.** Large species of *P. belemensis* group with female body length exceeding 600 µm. Three long and stout pairs of setae (*Z5*, *Jv5* and *Zv5*) at the posterior end of the body. Setae *S5* short (18–28). Dorsal plate with 43 pairs of setae, setae *r2*–*r6* and *R* series on the plate. Dorsal setae short (15–22) with the exception of *j1*, *r3* and *Z5*. Unsclerotised venter in female with 13 pairs of long setae (27–42) and one pair of postcoxal setae. Male with ventral spine on femur IV. Spermatodactyl relatively short (113–115).

**Female (Holotype).** **Dorsum.** Body length 602 (608–684 in five paratypes), width 407 (395–489). Dorsal plate covering whole dorsum, with slight transverse structure, 467 (458–476) long, 332 (320–332) wide. Dorsal plate with 43 pairs of short setae, series *r2*–*r6* and *R* on the plate. Setae *j1* 41 (39–44) long, strong, but setiform, setae *Z5* extremely long and strong, measuring 94 (80–95). Setae *z5* only slightly longer (18–22) than setae *j5* (15–17) and setae *r3* slightly longer (28–40) than *r2* (18–22). A row of fine denticles situated at the anterior margin of the plate. Peritreme reaching the level of *z1*. Small lyriform pores present posterior to *z1*.

**Venter.** Sternal plate 135 (132–159) long (presternum included), 376 (357–407) wide, finely structured in its lateral part, with posterior cornua small and blunt. Sternal setae 40–41 (37–44), *Mst* longer 51 (49–54). Two pairs of lyriform pores near *St1* and posterior to *St2*. Genital plate slightly broadened posterior to coxa IV, with scale-like structure. Genital setae measuring 42 (40–47). Anal plate pyriform, 110 (105–122) long, 87 (82–90) wide, with a pair of adanal setae 25 (24–30), a post-anal seta 69 (65–69) and a pair of circular pores

on its lateral border. Unsclerotised venter with 14 pairs of long setiform setae. Ventral setae measuring: *Jv1* 42 (39–42), *Jv2* 54 (49–54), *Jv5* 87 (84–88), *Zv1* 32 (27–32). Endopodal platelets present, metapodal platelets narrow (33–40 x 3–5), posterior to coxa IV.

*Gnathosoma*. Deutosternum with 7 rows of denticles, 5<sup>th</sup> and 6<sup>th</sup> rows widened and curved, row 5 concave, rows 6 and 7 convex. Epistome rounded and strongly toothed. Fixed chela with three fine subapical teeth, movable chela with three lateral teeth and membranous lobe. Inner seta on palpfemur and palpgenu flattened at the tip. Corniculi pointed and curved to inside.

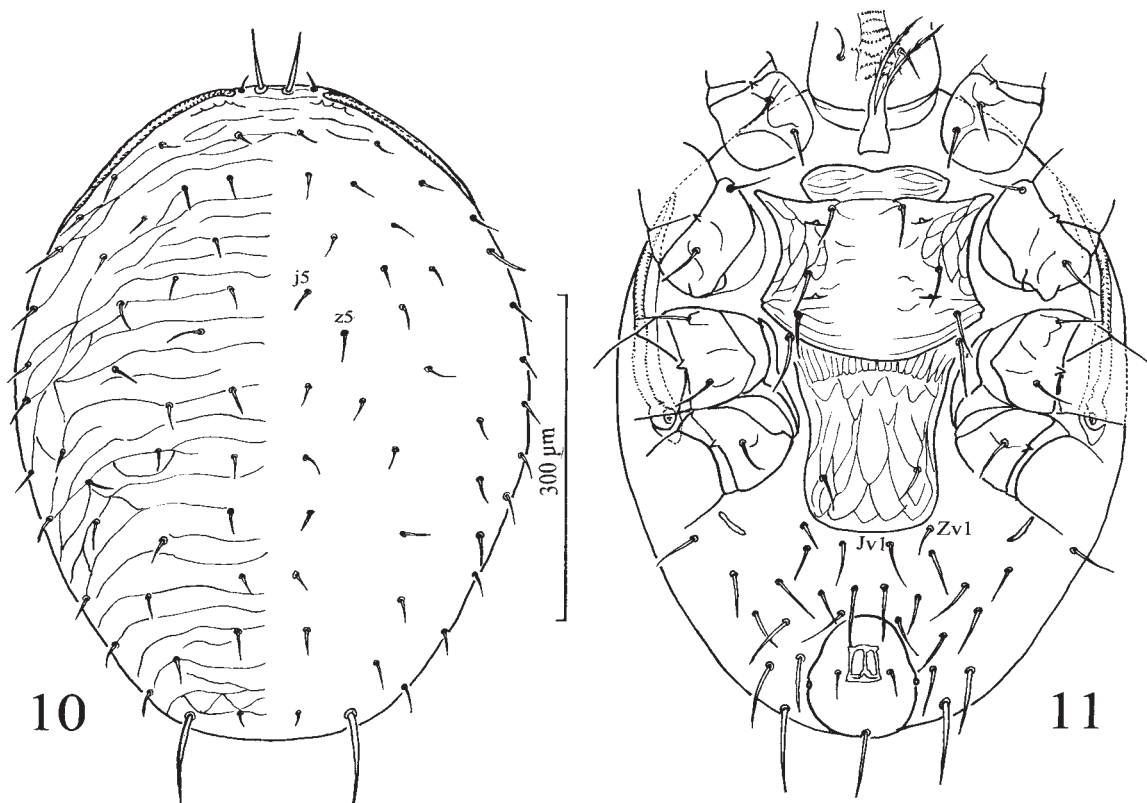
*Legs*. Tibia III with 8 setae, tibia IV with 10 setae. All leg setae setiform and smooth.

**Male.** *Dorsum*. Body length 495 (476–482 in three paratypes), width 338 (323–332). Dorsal plate with fine transverse pattern, 467 (458–476) long and 332 (320) wide, with 43 pairs of short fine setae. Seta *j1* and *r3* longer than remaining dorsal setae, measuring 39 (28–35) and 34 (32–34) respectively, setae *Z5* 83 (76–81) long. Remaining dorsal setae short, measuring 14–20, except, *z1* and *j5* very short (10–12). A pair of lyriform pores situated near *z1* setae. Peritreme ending at level of *z1*.

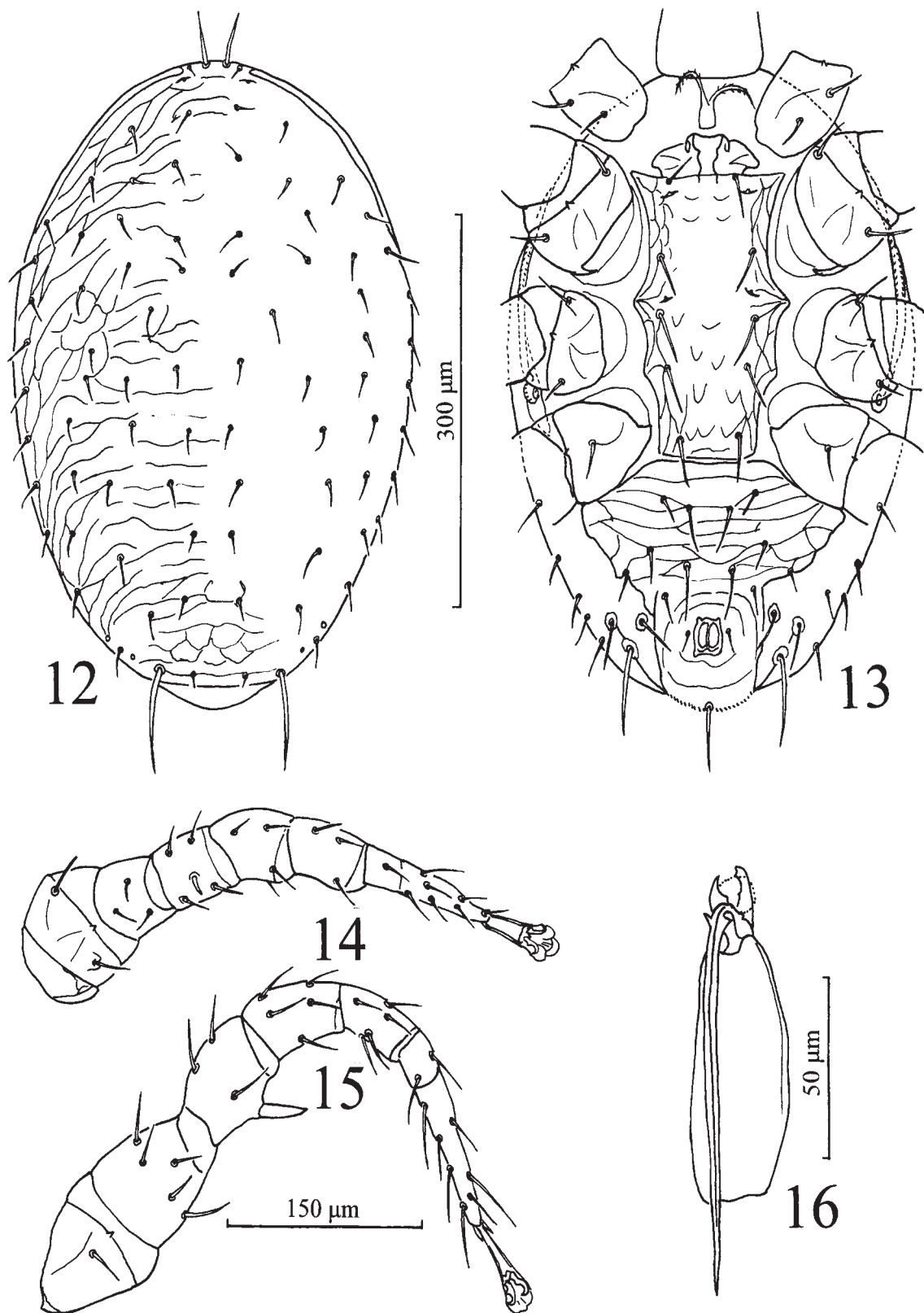
*Venter*. Genitoventral plate 189 (184–189) long (including genital pore), 220 (206–213) wide, with fine scale-like structure. Genitoventral setae 29–34 long, except *Gv4* which are 42 (39–42) long. Two pairs of lyriform pores are present near *Gv1* and between *Gv2* and *Gv3*. Ventri-anal plate broadly triangular, narrowed in anal part, transversely structured, 189 (184–189) long, 220 (206–213) wide. There are 6 pairs of ventral setae, a pair of adanal setae 20 (20–24) and a long post-anal seta 56 (49–52). Setae *Zv1* short 20 (17–20), *Jv1* 30 (30–32) long, *Jv2* 44 (37–39). Setae *Jv5* extremely long 59 (50–56), situated similarly as *Jv4* and *Zv4* on small sclerotized platelets. Peritremal plate narrow.

*Gnathosoma*: Deutosternum as in female, spermatodactyl relatively short, measuring 115 (113–115) only. Fixed chela with two teeth, movable chela with one tooth.

*Legs*: Legs II slightly thickened with some posteroventral setae slightly thickened. Strong ventral spine on femur IV present. All setae on legs IV setiform and smooth. Tibia III with 8 setae, tibia IV with 10 setae.



**FIGURES 10–11.** *Proctolaelaps naskreckii* Dusbabek & Havlicek, **sp. nov.**, female. Fig. 10. Dorsal view. Fig. 11. Ventral view.



**FIGURES 12–16.** *Proctolaelaps naskreckii* Dusbabek & Havlicek, **sp. nov.**, male. Fig. 12. Dorsal view. Fig. 13. Ventral view. Fig. 14. Leg II ventrally. Fig. 15. Leg IV ventrally. Fig. 16. Chelicera and spermatodactyl.

**Notes.** The new species differs from other species of the *P. belemensis* group in body and shield measurements and in the length of male spermatodactyl. The presence of 13 pairs of ventral setae on unsclerotised



integument in the female, and the presence of setae *Jv*5, *Jv*4 and *Zv*4 on small sclerotized platelets in the male also help to distinguish the new species from other known species of the *P. belemensis* group.

The males and females of *P. threnetes* Dusbabek & Literak, sp.nov. and *P. naskreckii* Dusbabek & Havlicek, **sp. nov.** were associated according to the following criteria. In both cases males and females were collected together from the same host individual. No other males were recorded in association with females of these two species. In both cases the main recognition characters of females occurred also in males: Setae *j*1 and *r*3 with lateral bulbous swelling or relative long dorsal setae of *j*, *J*, *z*, and *Z* series, namely the relation of *S*5 and *Z*5 in *P. threnetes*, and setae *j*1 and *r*3 without lateral bulbous swelling, dorsal setae of *j*, *J*, *z*, and *Z* series short, including seta *S*5 which are clearly shorter than the half of *Z*5. We have collected two more males (two distinct species) which have no common characters with *P. chalybura* Dusbabek & Capek, sp. nov. Because two only specimens were collected, we were not able to associate them to any known *Proctolaelaps* species.

**Etymology.** The species is dedicated to Dr. Piotr Naskrecki, Conservation International and Harvard University, USA, a specialist in hummingbird flower mites of the family Ascidae.

### ***Proctolaelaps chalybura* Dusbabek & Capek, sp. nov.**

(Figs. 17–18)

**Type material.** Female holotype and one female paratype ex *Chalybura urochrysia*, Costa Rica, Barbilla NP, 570 m elevation, September 2004, coll. I. Literak. Female holotype, and one female paratype on one slide are deposited at the type collection of the Biology Centre of the AS CR, Institute of Parasitology, Ceske Budejovice, Czech Republic, under the accession number CSAV 2007. Some paratypes are deposited in the collection of the British Museum (Natural History), London, UK, in Museum of Biological Diversity, the Ohio State University, 1315 Kinnear Road, Columbus, OH 43212, USA, and in Instituto Nacional de Biodiversidad, P.O.Box 22-3100, Santo Domingo de Heredia, Costa Rica.

**Material examined.** Four females ex 3 specimens of *Chalybura urochrysia*, the same data as holotype; 2 females ex 2 specimens of *Amazilia tzacatl* and 2 females ex *Phaethornis superciliosus*, the same locality and data as holotype, all coll. I. Literak.

**Diagnosis** (Female only, male unknown). Species of *P. belemensis* group with setae *j*1 strong and row 5 of deutosternal teeth broad and concave, row 6 convex. Body length rarely exceeding 600 µm. Lateral setae *S* and *R* series longer than inner setae (series *j* and *J*). Setae *Z*5, *S*5 and *R*5 long and thickened, frequently with lateral bulbous swelling, setae *S*4 short. Ventral setae *Jv* 1–3 and *Zv* 1–3 short and setiform, other ventral setae thickened and often with lateral bulbous swelling. Metapodal platelets long and extremely narrow (37 x 5 µm).

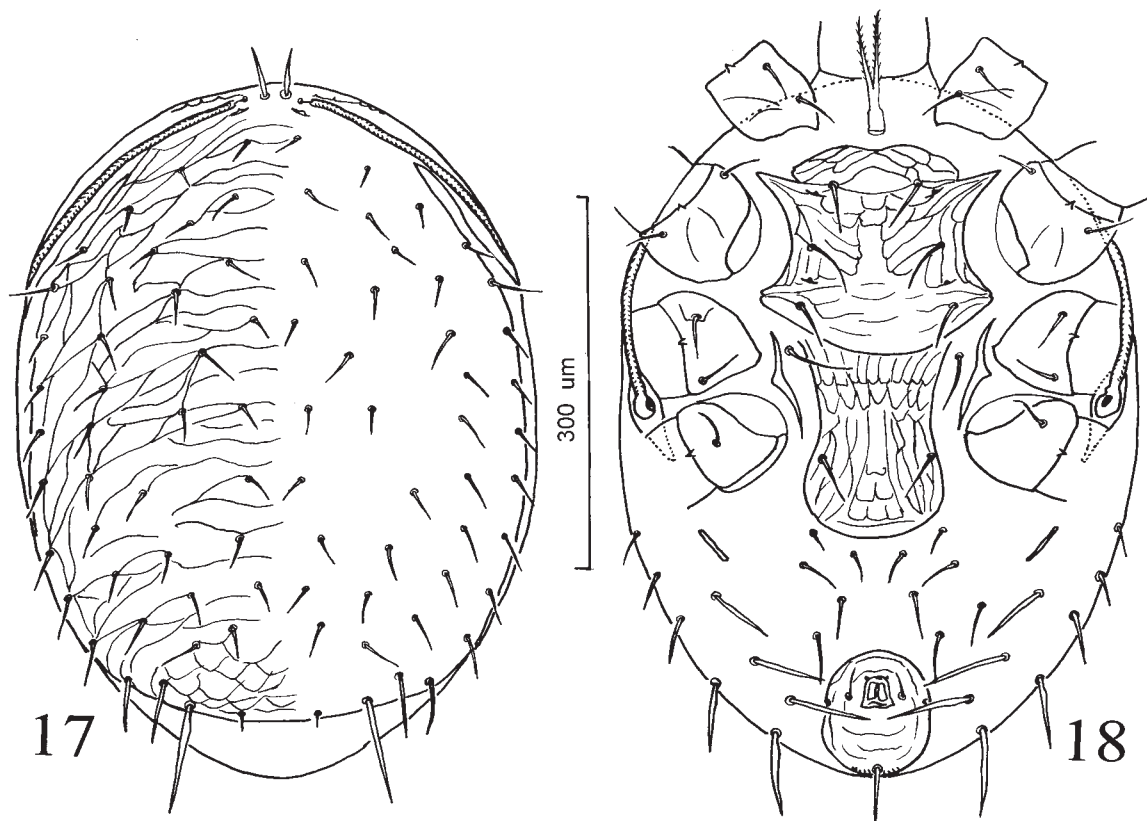
**Female. Dorsum:** Body length 595 (564–589 in four paratypes, 652 in one paratype), width 395 (345–370), oval. Dorsal plate covering the whole dorsum, 520 (508–533) long, 351 (320–345) wide, finely structured as figured, fused with peritrematal shields at the level of *z*2. Dorsal plate with 43 pairs of setae, *r*1 absent, setae *z*1 and *J*5 microsetae. Setae *j*1 strong, often with lateral bulbous swelling, 37 (37–40) long. Setae *z*5 30 (28–32), almost twice as long as *j*5 17 (17–19), *r*3 longer 37 (34–38) than *r*2 27 (27–30). Setae *Z*5 extremely long, measuring 81 (78–83), setae *S*5 47 (39–47). Posterior to *z*1 a pair of lyriform pores. Peritreme reaching setae *z*1.

**Venter:** Sternal plate including presternum 132 (127–142) long, 127 (125–135) wide at the level of posterior cornua, finely structured. Three pairs of sternal setae (34–39), one pair of lyriform pores posterolateral to *St*1 and between setae *St*2 and *St*3. Genital plate slightly enlarged posterior to coxa IV, finely structured, with a pair of genital setae 38 (34–35). Metasternal setae 44 (41–42) long, situated on soft integument. Anal plate oval, 98 (98–113) long, 78 (73–78) wide, slightly narrowed medially, with a pair of lateral pores, a pair of ada-

nal setae 22 (22–24) and an unpaired post-anal seta (59–64, broken in holotype). Endopodal platelets between coxae III and IV and genital plate. Metapodal platelets posterior to coxae IV, long and very narrow (37 x 5). Peritremal platelets narrow. Unsclerotised venter with 14 pairs of setae, *Jv1*–5, *Zv1*–5, *Lv4* and 3 pairs of *UR* series. Setae *Jv1*–3 and *Zv1*–3 setiform, other setae strong, rather spine-like and often with lateral bulbous swelling. Setae *Jv1* 34 (32–37), *Jv2* 44 (40–46), *Zv1* 30 (25–30), *Jv4* and *Zv4* 56 (54–62), *Jv5* 76 (72–78) long. Setae of *UR* series decreasing in length anteriorly.

**Gnathosoma:** Deutosternum with row 5 concave and row 6 slightly convex. One internal seta on palpfemur and palptibia flattened at tip. Tarsal claw deeply bifurcate. Epistome rounded and strongly toothed. Fixed chela with three fine subapical teeth, movable chela with three lateral teeth and membranous lobe. Corniculi pointed and curved inward.

**Legs:** All leg setae setiform and smooth. Tibia III with 8–9 setae, tibia IV with 10 setae.



**FIGURES 17–18.** *Proctolaelaps chalybura* Dusbabek & Capek, **sp. nov.**, female. Fig. 17. Dorsal view. Fig. 18. Ventral view.

**Notes.** The new species can be distinguished from other known species of the *P. belemensis* group by the number and arrangement of ventral setae. In *P. chalybura* **sp. nov.** there are 14 pairs of setae, setae of *Jv1*–3 and *Zv1*–3 being fine and shorter than other ventral setae (*UR* series excluding). Some ventral setae have a lateral bulbous swelling. Setae *r2* are clearly shorter than *r3*. The anal plate is oval with a broad anterior margin, and the metapodal platelet extremely narrow and long. The number of 14 ventral setae occurs only in *P. naskreckii* Dusbabek & Havlicek, **sp. nov.**, but the ventral setae are longer in this species; in remaining species of the *P. belemensis* group, the number of ventral setae is smaller (10–12) and they are not so strictly differentiated. Lateral bulbous swelling on some setae occurs only in *P. threnetes* **sp. nov.**, in which the dorsal setae, namely *r2* and *r3*, are markedly longer. The anal plate in other species is egg-shaped or pyriform, the metapodal platelets shorter and broader.

**Etymology.** The name of the new species is derived from the generic name of type host, *Chalybura urochrysia*.

### Key to the species of the flower mites of *Proctolaelaps belemensis* species group

All species of *P. belemensis* group are characterized in both sexes by stout and spine-like dorsal setae *j1* and by deutosternal teeth, which are arranged in 7 rows of denticles, 5<sup>th</sup> and 6<sup>th</sup> rows widened and curved, row 5 concave, and rows 6 and 7 convex. One internal seta on palpfemur and palptibia is flattened at the tip. The palpal claws are deeply bifurcate. The epistome is rounded and strongly toothed. The fixed chela has 3 subapical teeth, and the movable chela has 3 lateral teeth and a membranous lobe. The corniculi pointed and curved inward. Males are characterized by a long spermatodactyl and presence or absence of spine-like ventral seta on femur IV.

#### Females

1. Dorsal shield length less than 480 µm ..... *P. contumex* OConnor *et al.*, 1991  
Dorsal shield length greater than 500 µm ..... 2
2. Setae *j1* length less than 30 µm, setae *Z5* length less than 70 µm ..... *P. spiralis* Hyland *et al.*, 1978  
Setae *j1* length greater than 30 µm, setae *Z5* length greater than 70 µm ..... 3
3. Some dorsal and ventral setae (*j1*, *r3*, *Jv 4*, *Jv5*, *Zv4*, *Zv5*) frequently with lateral bulbous swelling. Setae *S5* length about one half or more of length of setae *Z5* ..... 4  
Dorsal setae without lateral bulbous swelling. Setae *S5* shorter than one half of *Z5* ..... 5
4. Dorsal plate 540–580 µm long, setae *r2* 30–36 µm, *r3* 40–47 µm long, *Z5* setiform, 90–95 µm long. Setae *Jv5* measuring 80–88 µm ..... *P. threnetes* **sp. nov.**  
Dorsal plate 500–530 µm long, setae *r2* 27–30 µm, *r3* 34–38 µm long, *Z5* spine-like, 78–83 µm. Setae *Jv5* measuring 72–76 µm ..... *P. chalybura* **sp. nov.**
5. Dorsal shield length 585–644 µm ..... *P. contentiosus* OConnor *et al.*, 1991  
Dorsal shield length less than 585 µm ..... 6
6. Anterior marginal setae *r3* distinctly longer than adjacent marginal setae *r2* and *r4* ..... 7  
Anterior marginal setae *r3* similar in length to *r2* and *r4* ..... *P. belemensis* Fain *et al.*, 1977
7. Dorsal setae very short, setae *j5* subequal to *z5*. Setae *j1* measuring 33 µm, *j2*, *z1*, *s1* and *J5* 8–11 µm, most other dorsal setae subequal, 13–15 µm long. Setae *Z5* measuring 106 µm. Setae *r3* (24 µm) only slightly longer than *r2* (22 µm) ..... *P. certator* OConnor *et al.*, 1991  
Dorsal setae not very short, setae *j5* (15–17 µm) distinctly shorter than *z5* (18–22 µm). Setae *j1* measuring 39–44 µm, *j2*, *z1*, *s1* and *J5* 10–20 µm long, most other dorsal setae 18–22 µm. Setae *Z5* 80–95 µm. Setae *r3* (30 µm) almost one third longer than *r2* (18–22 µm) ..... *P. naskreckii* **sp. nov.**

#### Males (males of *P. spiralis* and *P. chalybura* Dusbabek & Capek, **sp. nov.** are unknown)

1. Femur IV with a strong sclerotized spine on ventral face. Setae *j1* and *r3* spine-like and smooth. Spermatodactyl length less than 200 µm ..... 2  
Femur IV without ventral sclerotized spine. Spermatodactyl length 250–330 µm ..... *P. threnetes* **sp. nov.**
2. Spermatodactyl length less than 120 µm ..... 3  
Spermatodactyl length greater than 120 µm ..... 4
3. Spermatodactyl length 100–105 µm ..... *P. contumex* OConnor *et al.*, 1991  
Spermatodactyl length 113–115 µm ..... *P. naskreckii* **sp. nov.**
4. Spermatodactyl length 140 µm ..... *P. belemensis* Fain *et al.*, 1977  
Spermatodactyl greater than 150 µm ..... 5

5. Spermatodactyl length 160–165  $\mu\text{m}$ ..... *P. contentiosus* OConnor *et al.*, 1991  
 Spermatodactyl length 180–185  $\mu\text{m}$ ..... *P. certator* OConnor *et al.*, 1991

### Genus *Tropicoseius* Baker & Yunker, 1964

#### *Tropicoseius erro* Baker & Yunker, 1964

The species was described from the nasal turbinates of hummingbird *Phaethornis guy* (Lesson, 1832) in Panama and later collected from *Phaethornis syrmatorphorus* (Gould, 1851) in Costa Rica and Colombia. Naskrecki & Colwell (1998) examined the species on diverse *Psychotria* spp. (Rubiaceae), *Costus* spp. (Costaceae), *Heliconia sarapiquensis* (Heliconiaceae) and other hummingbird-pollinated plants in Costa Rica.

*Material examined.* Two females and one male from *Phaethornis superciliosus*, Hitoy Cerere BR, September 3, 2004; 1 female from *Amazilia tzacatl* of the same data and locality. All coll. I. Literák.

#### *Tropicoseius fairchildi* Baker & Yunker, 1964

This species was also described from the nasal turbinates of hummingbird *Phaethornis guy* in Panama. Naskrecki & Colwell (1998) examined type specimens of *Rhinoseius eutoxeres* Fain & Hyland, 1980 from *Eutoxeres aquila* and *R. waidei* Fain & Hyland, 1980 from *Phaethornis guy*, both from Colombia, and concluded that morphological characteristics of both these species fit well into range of intraspecific variation of *T. fairchildi* and are therefore identical to this species. This mite also was collected in Panama, Ecuador and Costa Rica, exclusively from different *Heliconia* spp. (Heliconiaceae). In Costa Rica it was also found on the hummingbirds *Campylopterus hemileucurus mellitus* Bangs, 1902 and *Eutoxeres aquila salvini* Gould, 1868 (Naskrecki & Colwell 1998).

*Material examined.* Eleven females from six specimens of *Eutoxeres aquila*, Barbilla NP, September 2004, coll. I. Literák.

#### *Tropicoseius colwelli* (Hunter, 1972)

This species appears to be endemic to Costa Rica. It was collected there from flowers of *Centropogon* spp. (Campanulaceae) and *Tropaeolum* spp. (Tropaeolaceae). It was found also on the hummingbirds *Campylopterus hemileucurus mellitus* and *Eugenes fulgens spectabilis* (Lawrence, 1867) (Hunter, 1972; Naskrecki & Colwell, 1998).

*Material examined.* Twenty females, 2 homeomorphic males, 2 deutonymphs and 1 protonymph from 4 hummingbird feeders at Turrialba Lodge, Costa Rica, August 2, 2004, coll. I. Literák.

#### *Tropicoseius* cf. *trinitatis* (Fain *et al.*, 1977)

The species was described from *Glaucis hirsutus* (Gmelin, 1788) and also collected on *Phaethornis guy* in Trinidad (Fain *et al.*, 1977a, b). OConnor *et al.* (1991) collected the mite from the same host and from flowers of *Heliconia hirsuta* and *H. bihai* (Heliconiaceae). The *Heliconia* spp. are probably exclusive host plants of this mite in Trinidad (Naskrecki & Colwell, 1998). This is the first record of it outside Trinidad.

*Material examined.* One female from *Phaethornis superciliosus*, Hitoy Cerere BR, August 2004, coll. I. Literák.

### ***Tropicoseius colombiensis* (Fain & Hyland, 1980)**

This species was described from Colombia from the hummingbirds *Phaethornis guy*, *P. syrmatophorus*, *P. superciliosus* and *Eutoxeres aquila*. Naskrecki & Colwell (1998) reported this species predominantly from *Heliconia* spp. (Heliconiaceae) from Nicaragua, Colombia, Ecuador and Costa Rica.

*Material examined.* Two females from *Eutoxeres aquila*, Hitoy Cerere BR, August 2004, coll. I. Literak; 8 females and 1 deutonymph from the same host, Barbilla NP, September 2004, coll. I. Literak.

### **Genus *Rhinoseius* Baker & Yunker, 1964**

#### ***Rhinoseius tiptoni* Baker & Yunker, 1964**

The type material originates from *Phaethornis guy*, and paratypes from the hummingbird *Lamporis castaneiventris* (Gould, 1851) from Panama. It feeds primarily on flowers of Gesneriaceae in Costa Rica (Naskrecki & Colwell, 1998).

*Material examined.* One female from *Phaethornis superciliosus*, Hitoy Cerere BR, August 2004; 2 females from the same host, Barbilla NP, September 2004, all coll. I. Literak.

#### ***Rhinoseius* cf. *antioquiensis* Fain & Hyland, 1980**

(Figs. 19–23)

In five species of *Rhinoseius* some dorsal setae in the anterior part of the male opisthonotal shield are strongly modified, thick and spine-like: *R. richardsoni* Hunter, 1972, *R. panamensis* Fain *et al.*, 1977, *R. antioquiensis* Fain & Hyland, 1980, *R. rafinskii* Micherdzinski & Lukoschus, 1980 and *R. nadachowskyi* Wiese & Fain, 1993. While in *R. nadachowskyi* and *R. rafinskii* these setae are multiple (3 pairs in *R. rafinskii* and 5 pairs in *R. nadachowskyi*), in the remaining species only two pairs (*J1* and *Z1*) are modified. Naskrecki & Colwell, (1998) synonymized *R. panamensis* with *R. richardsoni*. They discussed the variability of the male opisthonotal and opisthoventral setae and consider *R. panamensis* to be the heteromorphic form of *R. panamensis*, in which these setae are setiform. According to these authors, *R. richardsoni* differs from *R. antioquiensis* mainly by the absence of setae *z1*, the thick opisthonotal setae *Z5* and shorter peritreme, extending anteriorly to the level of *z2* or *z4*.

Our specimen represents an intermediate form between *R. richardsoni* and *R. antioquiensis*, having setae *Z5* and *S5* spine-like rather than flageliform, and the peritreme reaching the level of *z2*. However, the presence of setae *z1*, and short dorsal propodosomal setae lead us to the conclusion that our specimen is assignable to *R. antioquiensis* rather than *R. richardsoni*. We believe that the differences are those of homo- and heteromorphism common in males of these mites.

Fain & Hyland (1980) collected *R. antioquiensis* on the head feathers of the Colombian hummingbirds *Chalybura urochrysis*, *Androdon aequatorialis* Gould, 1863 and *Phaethornis guy*. Naskrecki & Colwell (1998) reported this mite also from the plants *Cavendishia lindauiana* and *C. palustris* (Ericaceae) from Colombia. Our record is the first outside Colombia.

*Material examined.* One male from *Amazilia tzacatl*, Barbilla NP, September 2004, coll. I. Literak.

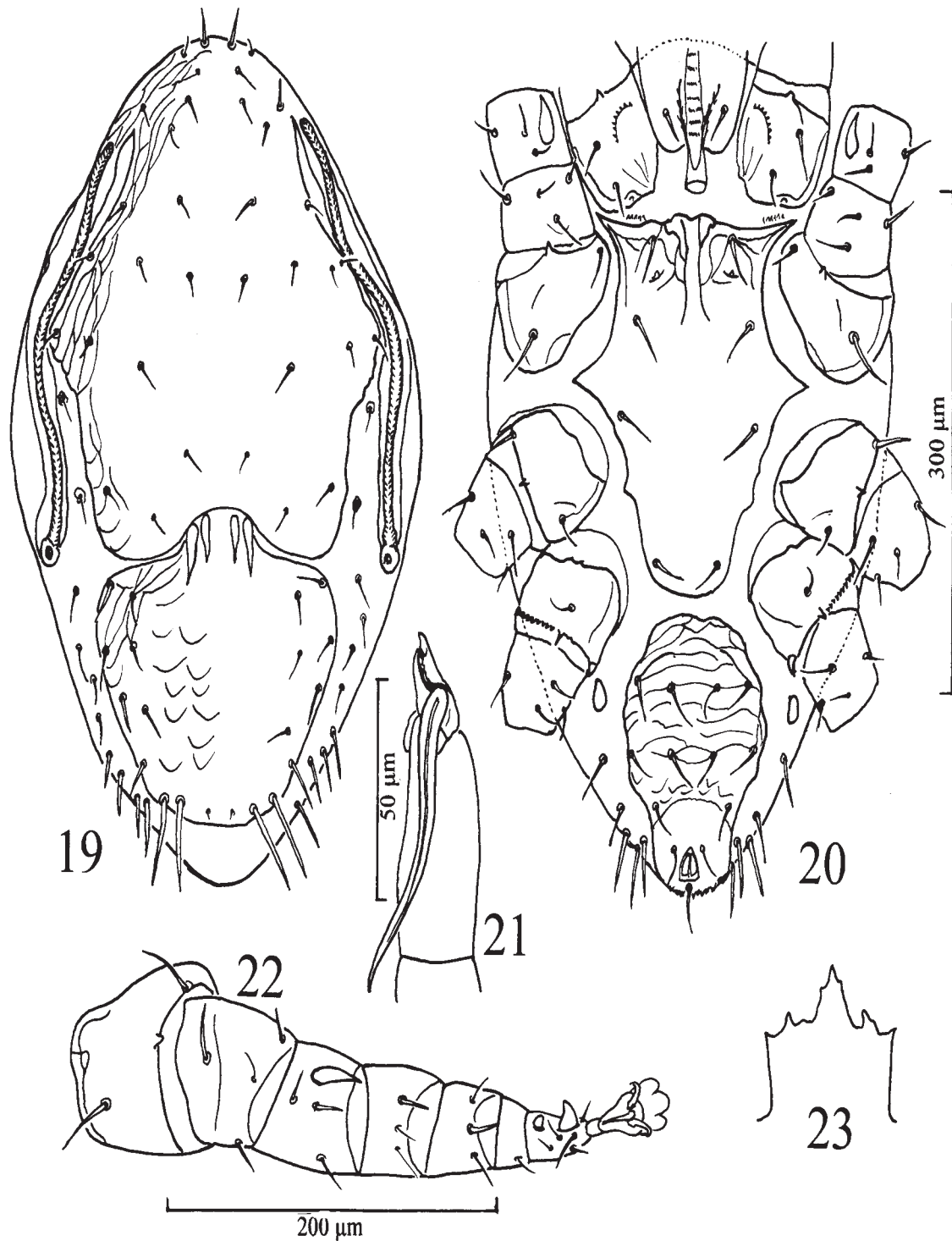
#### ***Rhinoseius androdon* Fain & Hyland, 1980**

This mite was described from material from the hummingbird *Androdon aequatorialis* from Colombia, and



later collected from the hummingbirds *Amazilia rosenbergi* (Boucard, 1895), *Phaethornis yaruqui* (Bourcier, 1851) and *Thalurania colombica* (Bourcier, 1843) and the plant *Cavendishia* sp. (Ohmer *et al.*, 1991). Naskrecki & Colwell (1998) reported it from *Cavendishia coccinea* and consider the flowers of plant family Ericaceae to be typical plant hosts at higher elevations.

*Material examined.* Two males and 2 females from *Chalybura urochrysis*, Barbilla NP, September 2004, coll. I. Literak.



**FIGURES 19–23.** *Rhinoseius* cf. *antioquiensis* Fain & Hyland, 1980, male. Fig. 19. Dorsal view. Fig. 20. Ventral view. Fig. 21. Chelicera and spermatodactyl. Fig. 22. Leg II ventrally. Fig. 23. Epistome.

## Discussion

The genus *Proctolaelaps* is distributed all over the world and comprises both predatory and microphytophagous species. Flower inhabiting and phoretic species occur in Africa and Australia, but the greatest number of species has been described from Central and South America (OConnor *et al.*, 1991). Thirteen species have been described from hummingbird-pollinated flowers or hummingbird nares in Central and South America. According to OConnor *et al.* (1991), they can be divided into two species groups, the *Proctolaelaps kirmsei* group (6 species) and the *Proctolaelaps belemensis* group (7 species). The *P. belemensis* group includes morphologically closely related species that predominantly differ in measurements of the body, plates and setae in females in both sexes, and the chaetotaxy and the length of spermatodactyl in males. OConnor *et al.* (1991) discussed the validity of species of this species group because of the minor morphological differences. They also mentioned the possibility of host plant influence on morphological characters in different populations. However, they recalled the differences in morphology of the male spermatodactyl, a genital character that is perhaps less prone to influence by host plant morphology. As these species exhibit distinct host plant preferences, and no morphological intermediates occur, they regarded them as valid separate species. We accept this species concept in *P. belemensis* group and consider our newly described forms to also be valid species.

Fain *et al.* (1977) noted the possibility that all New World bird-phoretic species of *Proctolaelaps* could belong to an undescribed genus intermediate between *Rhinoseius* and *Proctolaelaps*. They mentioned the reduced cheliceral dentition and presence of a ventral spur on femur IV in males among the unique characters of these mites. According to OConnor *et al.* (1991), the reduction of cheliceral dentition may be the result of transition from predation to nectar feeding as in other Ascidae.

Our study shows that the presence of the spur on femur IV in males is not a stable character in mites of the *P. belemensis* group, and that there is at least one species without this morphological character (i.e. *P. threnetes* Dusbabek & Literak, **sp. nov.**). Therefore it cannot be considered as a character at the generic level. However, a definitive resolution of this situation requires a thorough revision of the genus *Proctolaelaps*. Unpublished behavioral studies of Dr. R.K.Colwell reveal that, at least for *P. kirmsei*, this spur is a sexually selected character, used by males to interrupt matings of other males. The interloper mounts the mating male and hooks his spurs on the spurs of the mating male, leans backward, and pulls the male away from the female.

The genus *Tropicoseius* was established by Baker & Yunker (1964) and in 1965 it was synonymized with the genus *Rhinoseius* Baker & Yunker, 1964 by Lindquist & Evans (1965). Recently, Naskrecki & Colwell (1998) re-established the genus *Tropicoseius* as a valid genus and noted its unique synapomorphic features and the number of species sharing them. Their ecological and behavioural characteristics were also taken under consideration. Cladograms published in their paper clearly confirmed these arguments.

Among key characteristics in which the genus *Tropicoseius* differs from *Rhinoseius* is the presence of seta *pl2* on tibiae III and IV in *Rhinoseius* (altogether 9 and 10 setae on tibia III and IV respectively) and their absence in the genus *Tropicoseius* (8 and 9 setae on tibiae III and IV respectively). However, this character varies in some genera of Ascidae (Lindquist & Evans 1965) and also in *Proctolaelaps* spp. in our material (tibia III with 8–9 setae, tibia IV with 10 setae) and also varies within specimens of the same species. Therefore, it is a question to what degree this character is synapomorphic or apomorphic and therefore valid for the separation of these two genera. As there are more morphological differences between these two genera, we accepted the original concept of Baker & Yunker (1964) and consider *Rhinoseius* and *Tropicoseius* to be two distinct genera.

## Acknowledgements

We are grateful to the Ministry of Environment and Energy of Costa Rica for permission to conduct our study in Hitoy Cerere BR and Barbilla NP (permission No. 106-2004-OFAU). We appreciate the effort of all the staff of the reserve and park field stations for kind logistical support and access to their laboratories. We owe a special debt to Bernardo Calvo Rodriguez for his friendship and constant help in many ways. We also thank to Dr. Piotr Naskrecki, Conservation International and Harvard University, USA and Dr. Barry OConnor, University of Michigan, Ann Arbor, Michigan, USA who provided us with valuable publications, and Dr. Robert Colwell, University of Connecticut, USA, for sharing his observations of the behaviour of *P. kirmsei*. This study was partly supported by the Institutional Research Projects of the Biology Centre AS CR, Institute of Parasitology, Ceske Budejovice, Czech Republic No. AV OZ 60220518 and the Institute of Vertebrate Biology AS CR, Brno, Czech Republic No AV OZ 60930519.

## References

- Baker, E.W. & Yunker, C.E. (1964) New blattisociid mites (Acarina: Mesostigmata) from neotropical flowers and hummingbirds' nares. *Annals of the Entomological Society of America*, 57, 103–126.
- Berlese, A. (1923) Centuria sesta di Acari nuovi. *Redia*, 15, 237–262.
- Colwell, R.K. (1973) Competition and coexistence in a simple tropical community. *American Naturalist*, 107, 737–760.
- Colwell, R.K. (1995) Effect of nectar consumption by the hummingbird flower mite *Proctolaelaps kirmsei* on nectar availability in *Hamelia patens*. *Biotropica*, 27, 206–217.
- Colwell, R.K. & Naeem, S. (1999) Sexual sorting in hummingbird flower mites (Mesostigmata: Ascidae). *Annals of the Entomological Society of America*, 92, 952–959.
- Donato, F. & Kandler, M.M. (1994) *Plan general de manejo Reserva Biologica Hitoy Cerere. Anexo I: Sondeo Ecologico Rapido*. SPN and ICT, Costa Rica, 53–57.
- Dusbabek, F., Literak, I., Capek, M. & Havlicek, M. (2006) Three species of the genus *Pellonyssus* (Acari: Macronyssidae) including a new species from Costa Rican birds. *International Journal of Acarology*, 32, 175–178.
- Dusbabek, F. & Literak, I. (2006) *Lasioseius aquilarum* n. sp. (Acari: Ascidae), a new mite species from the nares of Costa Rican hummingbirds. *International Journal of Acarology*, 32, 293–296.
- Evans, G.O. (1992) *Principles of Acarology*. C.A.B. International, Wallingford, 563 pp.
- Fain, A. (1992) Notes on the flower mites of the genus *Rhinoseius* Baker and Yunker, 1964 (Acari: Ascidae), phoretic in the nares of hummingbirds with a key to known species. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Entomologie*, 62, 117–136.
- Fain, A. & Hyland, K. E. (1980) New species of the genus *Rhinoseius* Baker and Yunker, 1964 (Mesostigmata: Ascidae) phoretic on Colombian hummingbirds. *International Journal of Acarology*, 6, 15–24.
- Fain, A., Hyland, K. E. & Aitken, T.H.G. (1977) Flower mites of the family Ascidae phoretic in nasal cavities of birds (Acarina: Mesostigmata). *Acta Zoologica et Pathologica Antverpiensia*, 69, 99–154.
- Fain, A. & Mariaux, J. (1991) Notes on two mesostigmatic mites (Acari: Mesostigmata) recorded from sunbirds (Nectariniidae) in the Ivory-Coast. *Revue Suisse de Zoologie*, 98, 319–324.
- Haase, A. & Pröhl, H. (2002) Female activity patterns and aggressiveness in the strawberry poison frog *Dendrobates pumilio* (Anura: Dendrobatidae). *Amphibia-Reptilia*, 23, 129–140.
- Hunter, P.E. (1972) New *Rhinoseius* species (Mesostigmata: Ascidae) from Costa Rican hummingbirds. *Journal of the Georgia Entomological Society*, 7, 26–35.
- Hyland, K.E., Fain, A. & Moorhouse, A.S. (1978) Ascidae associated with the nasal cavities of Mexican birds (Acarina: Mesostigmata). *Journal of the New York Entomological Society*, 86, 260–267.
- Kaufman, K. (1990) *A Field Guide to Advanced Birding*. Houghton Mifflin Company, Boston and New York, 299 pp.
- Micherdzinski, W. & Lukoschus, F.S. (1980) *Rhinoseius rafinskii*, a new species from Ecuador and Venezuela (Acari, Gamasina, Ascidae). *Zoologische Mededelingen*, 55, 65–79.
- Lindquist, E.E. & Evans, G.O. (1965) Taxonomic concept in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina: Mesostigmata). *Memoirs of the Entomological Society of Canada*, 47, 1–64.
- Naskrecki, P. & Colwell, R.K. (1995) *Systematics and Host Plant Affiliations of Hummingbird Flower Mites of the Genera Tropicoseius Baker & Yunker and Rhinoseius Baker & Yunker (Acari: Mesostigmata: Ascidae)*. Thomas Say Publications in Entomology, Entomological Society of America, Lanham, Maryland, 185 pp.
- National Geographic Society (2002) *Field Guide to the Birds of North America*. 4<sup>th</sup> ed. National Geographic Society,

Washington, D.C., 480 pp.

- OConnor, B., Colwell, R.K. & Naeem, S. (1991) Flower mites of Trinidad II. The genus *Proctolaelaps* (Acari: Ascidae). *Great Basin Naturalist*, 51, 348–376.
- Ohmer, C., Fain, A. & Schuchmann, K.L. (1991) New ascid mites of the genera *Rhinoseius* Baker and Yunker, 1964 and *Lasioseius* Berlese, 1923 (Acari: Gamasida: Ascidae) associated with hummingbirds or hummingbird-pollinated flowers in southwestern Colombia. *Journal of Natural History*, 25, 481–497.
- Ridgley, R.S. & Gwynne, J.A. (1989) *A Guide to the Birds of Panama with Costa Rica, Nicaragua, and Honduras*. 2<sup>nd</sup> ed. Princeton University Press, Princeton, New Jersey, 534 pp.
- Ryke, A.J. (1964) Acarina associated with protea flowers in the Cape Province. *Journal of the Entomological Society of South Africa*, 26, 339–354.
- Savage, J.M. (2002) *The amphibians and reptiles of Costa Rica. A herpetofauna between two continents, between two seas*. University of Chicago Press, Chicago and London, 934 pp.
- Sibley, D.A. (2000) *National Audubon Society Sibley guide to birds*. Alfred A. Knopf, New York, 544 pp.
- Stiles, F.G. & Skutcha, A. (1989) *A guide to the birds of Costa Rica*. Christopher Helm, London, 511 pp.
- Treat, A.E. & Niederman, L. (1967) Three species of *Proctolaelaps* (Acarina, Mesostigmata) from noctuid moths. *American Museum Novitates*, 2312, 1–12.
- Tschapka, M. & Cunningham, S.A. (2004) Flower mites of *Calyptronyne ghiesbreghtiana* (Arecaceae): Evidence for dispersal using pollinating bats. *Biotropica*, 36, 377–381.
- Universidad de Costa Rica (2004) *Barbilla National Park*. <http://www.ticotourism.com>.
- Wiese, M.H.J. & Fain, A. (1993) New species of the genus *Rhinoseius* Baker & Yunker, 1964 (Acari: Mesostigmata: Ascidae) found in Colombia. *Bulletin & Annales de la Societe Royal Belge d'Entomologie*, 129, 69–101.

